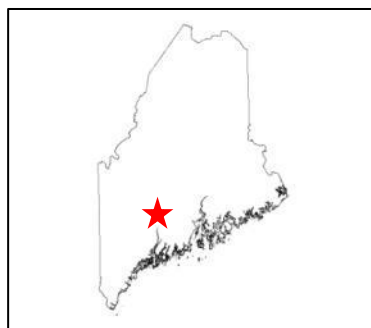


Geologic Site of the Month
February, 2015

***The Geology of Howard Hill,
Backdrop to the Maine State House, Augusta***



44° 18' 03" N, 69° 47' 36" W

By
Robert G. Marvinney



Introduction

Whether captured by the painter's brush or by the photographer's lens, the most iconic images of the Maine State House show the stately granite building against the verdant backdrop of Howard Hill. The juxtaposition of the center of policy with a natural landscape symbolizes the significant role played by natural resources in Maine's economy.



Courtesy of the [Maine Legislature](#)



Maine Geological Survey

Photo by R.G. Marvinney

Figure 1. 1836 painting of the State House by Charles Codman shown with a modern photograph.



Bedrock Geology

Geological processes have acted over eons to shape the metamorphic and igneous rocks of Howard Hill.

Metamorphic rocks. Much of central interior Maine is underlain with metamorphic rocks that originated as sediments in a deep ocean basin about 430 million years ago. What began as layers of sand and mud in that basin have been metamorphosed through heat and pressure associated with mountain building that produced the Appalachian Mountains around 400 million years ago. The sand layers became granofels (like [gneiss](#) except it lacks banding) and the mud layers became [schist](#). The mountain-building forces also folded the rocks so that they are now tilted on edge. The geologic map in Figure 2 shows the distribution of metamorphic rocks in various shades of green.

Igneous rocks. While there is great variety of igneous rocks exposed throughout Maine, a primary type in the Augusta area is granite. Granite, an intrusive igneous rock, formed when molten magma intruded into the Earth's crust and cooled at several miles depth to form solid rock. Eons of erosion have now exposed the granite at the surface. By mapping around the area, geologists have established that the granite cuts across the metamorphic rocks, indicating that the granite is younger. It's around 380 million years old. The pink areas on the geologic map in Figure 2 are underlain with granite.



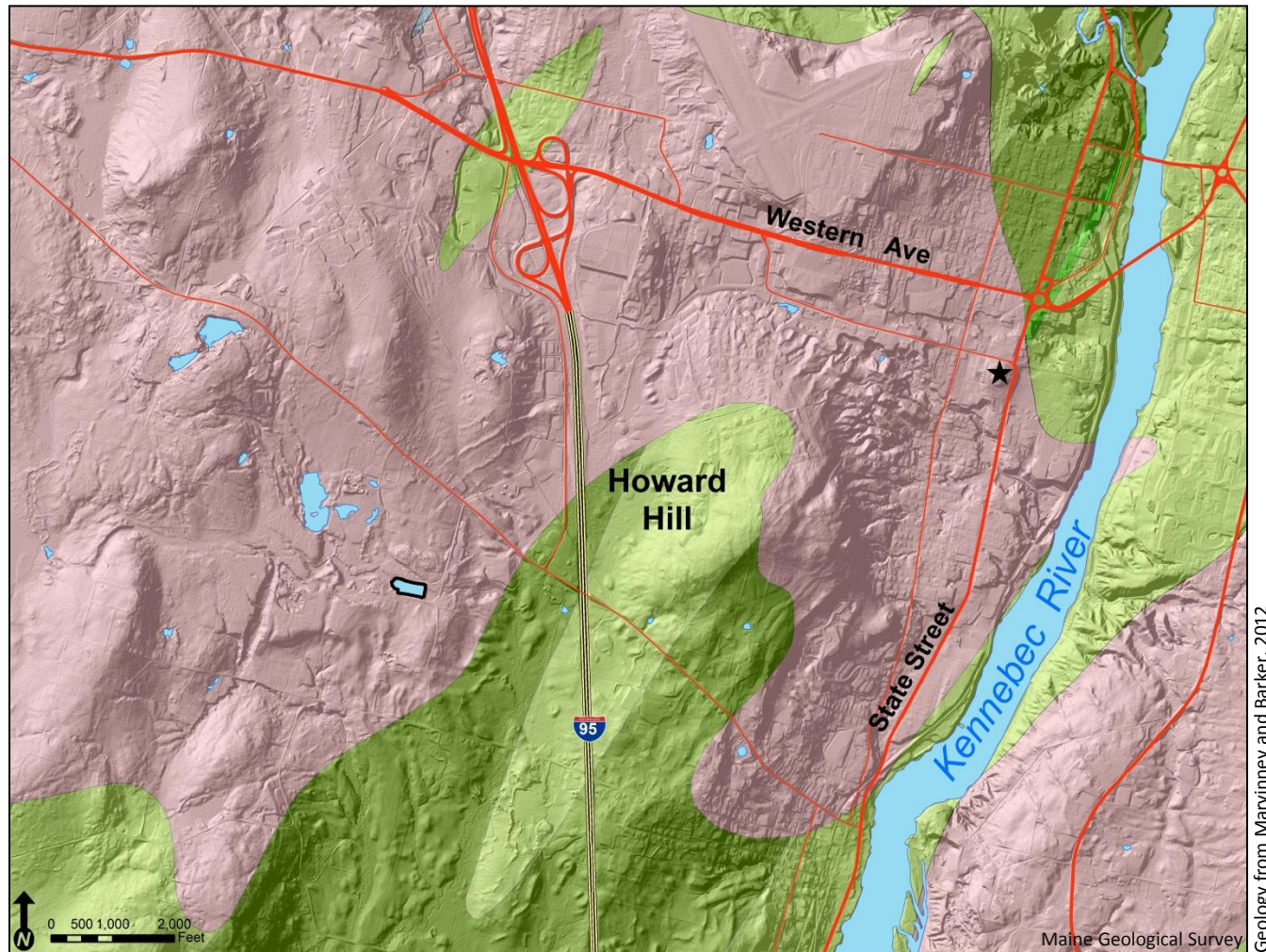
Bedrock Geologic Map

Figure 2. A portion of the bedrock geologic map of the Augusta quadrangle, shown on a shaded-relief base. Areas shown in shades of green are underlain with metamorphic rocks. Areas shown in shades of pink are underlain with granite. The Maine State House is located at the star symbol.



Metamorphic Rocks

Metamorphic rocks are well exposed on neighborhood streets on the western side of Howard Hill. The rocks are granofels of the Mayflower Hill Formation, which geologists have mapped in a broad belt extending to Waterville and beyond. In this outcrop, layering is tilted from upper right to lower left parallel to the arrow. The metamorphic mineral biotite mica imparts a purple hue to this rock. The greenish layers contain a different mineral (diopside).



Photo by Robert G. Marvinney

Figure 3. Mayflower Hill Formation exposed in a cul-de-sac at the south end of Parkwood Drive. View looking north.

Metamorphic Rocks

Interlayering of granofels and schist. Beneath the knife is a thick, light gray sandy layer, now metamorphosed to granofels. Above that is a darker layer of schist. At the top of the image, the layers of granofels and schist are thinner. The white rock in the center of the image is a small quartz vein.

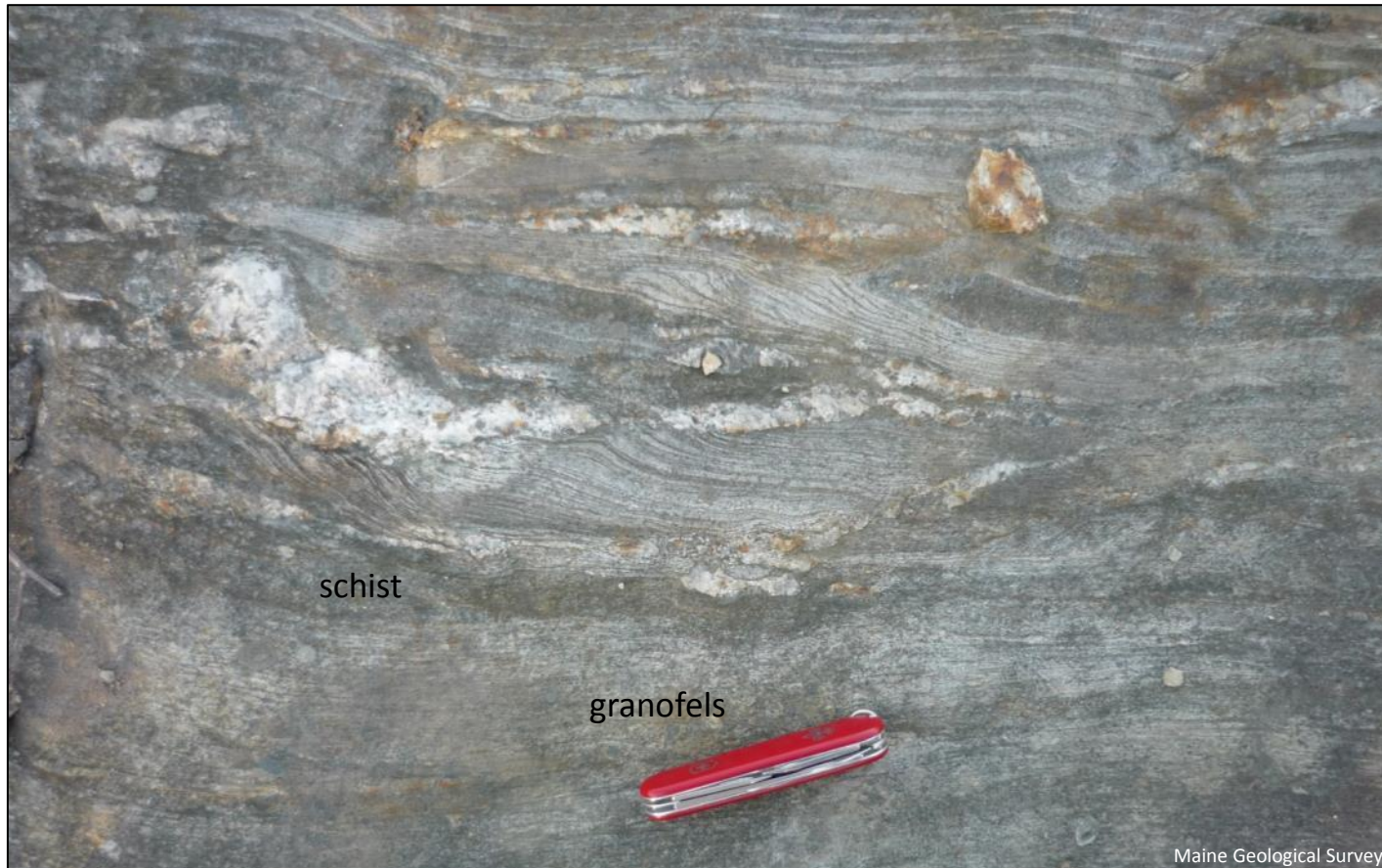


Figure 4. Layering in granofels of the Mayflower Hill Formation. View looking down on outcrop. Location same as in Figure 3.

Folds in Metamorphic Rocks

Thin granofels beds in the Mayflower Hill Formation show tight folding. Folding occurred around 400 million years ago when these rocks were at considerable depth in the crust. Rounded features on the layering are lichens growing on the rock surface.



Photo by Robert G. Marvinnay

Figure 5. Folded layering in granofels of the Mayflower Hill Formation. View looking down on outcrop. Location same as in Figure 3. In the next figure, the folds are traced in red for visibility.



Folds Highlighted in Metamorphic Rocks



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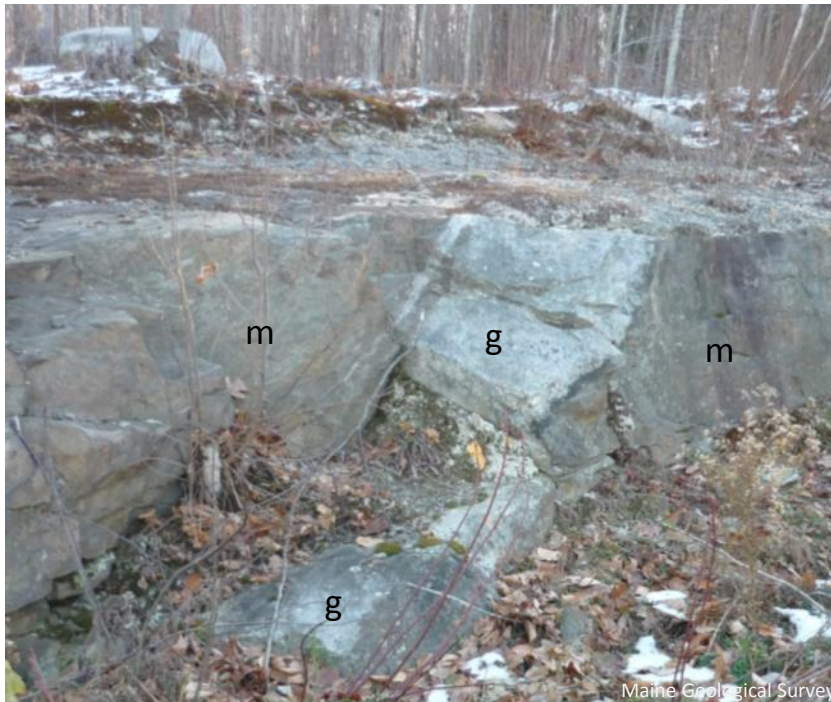
Photo by Robert G. Marvinn

Figure 6. The folds in Figure 5 are traced in red for visibility.



Granite dikes cross-cutting metamorphic rocks

Several granite dikes cut across the metamorphic rocks in exposures along the western side of the hill. A dike is sheet-like intrusion of igneous rock into a fracture. In this locality, a granite magma intruded into a nearly vertical fracture, then cooled.



Photos by Robert G. Marvinney

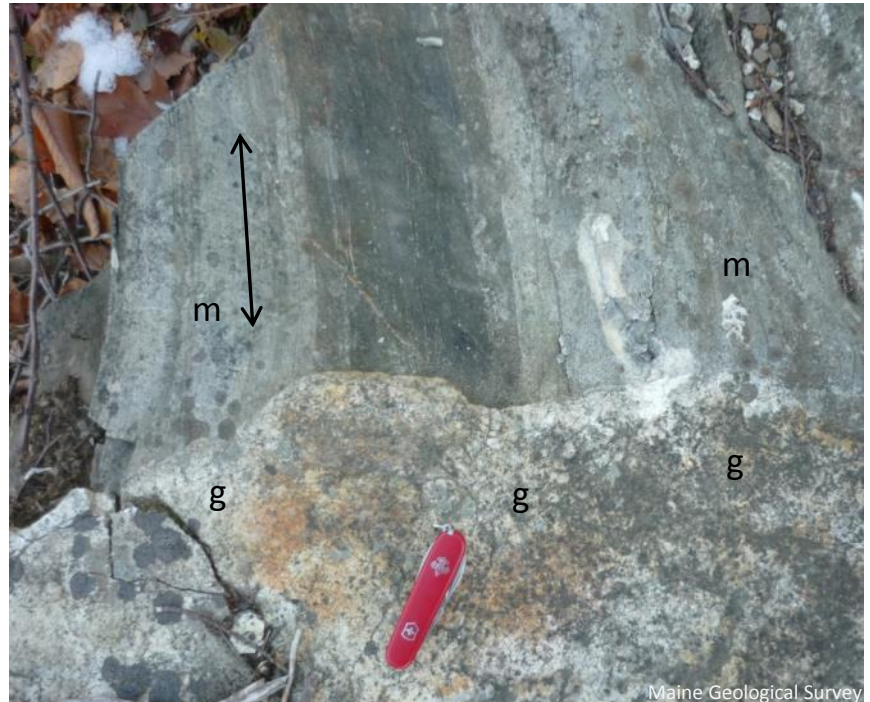


Figure 7. On the left, a granite dike (g) about 1 meter thick cuts across layering in the metamorphic rocks (m). In the image on the right, the sharp contact of the granite crosses the image from left to right just above the knife. It cuts across the layering in the metamorphic rocks which runs parallel to the arrow. (This image taken looking straight down at the surface.)

Granite

The eastern half of Howard Hill is underlain with granite, which is well exposed in the cliffs on the eastern side of the hill. Large jumbled blocks of granite form a talus slope below the steepest slopes on the eastern side of the hill. The granite is a uniform, massive fine-grained rock composed of white feldspar, gray quartz, and black biotite mica.



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Photos by Robert G. Marvinn



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Figure 8. On the left are large granite blocks in a talus slope beneath the steepest slopes on the eastern side of Howard Hill. On the right is a close-up of the fine-grained and evenly grained granite shown with a dime for scale.

Granite

The large vertical walls of granite seen in the cliffs on the eastern side of Howard Hill are joint surfaces. Joints are planar fractures, across which there has been no movement of rock. In the situation seen here, the joints made it easy for glaciers to pull large blocks of granite from the cliff. These joints probably developed through the expansion of the granite, as the substantial weight of rock above the granite intrusion was removed by erosion.



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Figure 9. The vertical surfaces on the left are defined by vertical, planar fractures – joints – in the granite. The close-up on the right shows a series of holes drilled in a line in the granite, demonstrating that this locality was once exploited by quarrymen to extract granite blocks for construction.

Glacial features

About 1 million years ago, the Great Ice Sheet began several phases of advance and retreat across the region. On top of Howard Hill in several locations are boulders that were rounded and transported by the glaciers. But technically these are not glacial erratics. Why not? Glacial erratics are glacially transported rocks that do not match the underlying bedrock. They were derived from different geology “up” glacier. At Howard Hill, these glacially transported boulders are granite and they sit on granite of the same composition.



Photo by Robert G. Marvinn

Figure 10. Glacially transported boulders near the summit of Howard Hill.



Summary

Through collaboration of the City of Augusta and the Kennebec Land Trust, there is an effort underway to conserve the natural landscape of Howard Hill for future generations. For more information on this project and how you might help, visit the website of the Kennebec Land Trust, (www.tklt.org)



Figure 11. The Maine State House as seen from the cliffs on the eastern side of Howard Hill.



References and Additional Information

Access to Howard Hill

Howard Hill is currently private property but has been open to the public for low-impact use such as hiking. An informal trail begins at the southern end of Ganneston Drive where there is space to park a few cars.

The City of Augusta and the Kennebec Land Trust have collaborated to purchase the Howard Hill property. It will become public open space by the end of 2015. For more information about supporting the effort visit the Kennebec Land Trust web site: www.tklt.org.

Howard Hill Preservation Project

Edwards, K. (2014, April 19). Augusta's Howard Hill quiet getaway in heart of city. *Kennebec Journal*. Retrieved from http://www.centralmaine.com/2014/04/19/augusta_s_howard_hill_quiet_getaway_in_heart_of_city/.

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"Howard Hill." *Vimeo*. Kennebec Land Trust, 7 Jan. 2015. Web. 29 Jan. 2015. <http://vimeo.com/116175764>.

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